Ozone Depleting Chemicals (ODCs) Management and Reduction at U.S. Army and Army Reserve Facilities

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Abstract

Managers and environmental coordinators responsible for implementing Pollution Prevention (P^2) initiatives, should be aware of global, federal (EPA), Army and Army Reserve regulations for ODCs. This paper identifies what is involved in the planning process of ODC elimination, and how to succeed in reducing current ODCs and ultimately eliminate them.

Ozone Science

The Earth's atmosphere is divided in several layers or regions. The lowest region, which extends from the Earth's surface up to about 10 kilometers (km) in altitude, is called the troposphere. Most human activities occur in this sphere. The next layer, the stratosphere, continues from 10 km to about 50 km. Most commercial airline traffic occurs in the lower part of the stratosphere. Atmospheric ozone is concentrated in the stratosphere, about 15 to 30 km above the Earth's surface. Ozone is a molecule containing three oxygen atoms, is blue in color and has a strong odor compared with normal oxygen, which has two atoms, is colorless and odorless.

Ozone plays a key role in the atmosphere. This ozone layer in the stratosphere absorbs about 95% of the radiation from the sun, (ultraviolet light called UVB) preventing it from reaching the planet's surface. Increased UV radiation in the troposphere, can result in increased amounts of photochemical smog and can contribute to global warming. UVB has been linked to many harmful effects, including various types of breathing problems, skin cancer, cataracts, is harmful to some crops, certain materials (e.g. plastics), and some forms of marine life.

An example of a reaction that occurs under incident UVB radiation is as follows:
$Cl + O_3 = ClO + O_2$
$ClO + O = Cl + O_2$, yielding $O_3 + O = 2O_2$ (Chlorine atoms are the catalysts in this reaction.)

At any given time, ozone molecules are constantly formed and destroyed in the stratosphere. The total amount remains relatively stable. Although ozone concentrations vary with naturally occurring sunspots, seasons, and latitude, these processes are understood and predicted by scientists. Scientific records have been established spanning several decades that detail normal ozone levels during these cycles. Each natural reduction in ozone levels has been followed by a recovery. However, in the last years, more convincing scientific evidence has shown that the ozone shield is being depleted well beyond changes due to natural processes. These changes have been attributed to manmade processes and chemicals, specifically to emission of a particular group of industrial chemicals called halogenated compounds. These halogenated compounds include common chlorofluorocarbon (CFC) groups, halon groups, methyl chloroform, carbon tetrachloride and hydrochlorofluorocarbons (HCFCs). These compounds have been classified based on their "ozone-depletion potential" (ODP), which indicates the ability of a chemical to destroy stratospheric ozone.

Ozone Regulations

42 U.S.C., Section 7671a(a) or Appendix A, 40 CFR Part 82, Subpart A, Title VI, Section 602 of the CAA, as amended in 1990, establishes two main classes of ODCs, Class I and Class II, which consist of individual groups of chemicals. The Class I chemicals are the most potent ozone depleters (often containing a bromine-an effective catalyst in ozone depletion) and Class II chemicals include other less potent ozone depleters. In an attempt to reduce the effect of ODCs on the environment, more than 125 nations (including the United States) signed an international agreement known as the Montreal Protocol to limit ODC production. In 1990, the Montreal Protocol, as well as the Clean Air Act were amended to mandate the eventual elimination of the manufacture and use of most ODCs. The CAA Title VI provides stricter controls on ODCs than the Montreal Protocol, but adheres to a similar phaseout schedule. The CAA also requires HCFC production to be phased out by the year 2015, five years ahead of the Montreal Protocol schedule.

The U.S. Congress took independent initiative to emphasize the need for the defense agencies and military departments to reduce requirements that lead to the use of ODC's. The National Defense Authorization Act for Fiscal Year 1993, Public Law 102-484, includes legislation addressing ODCs in Section 325 and 326. Section 325 titled "Evaluation of Use of Ozone-Depleting Substances by the Department of Defense," places a requirement on the Director of the Defense Logistic Agency (DLA) to evaluate the use of Class I and Class II ODCs by the military departments and defense agencies and report the results of the evaluation to Congress. Section 326 titled "Elimination of Use of Class I, Ozone-Depleting Substances in Certain Military Procurement Contracts," directs the DoD to put in place procedures to evaluate contractual requirements that lead to the use of Class I ODCs. In recognition of the above mandate, the US Army implemented the guidance of DoD Directive 6050.9 (1989) and the Montreal Protocol by issuing Headquarters, Department of the Army letter (HQDA LTR) 200-90-1, "Elimination or Minimizing Atmospheric Emissions of Ozone-Depleting Substances." This letter provided important direction toward eliminating the use of halons and CFCs for both tactical and nontactical applications, and authorized the formation of a General Officer Steering Committee (GOSC). HQDA 200-92-1 was incorporated into AR 200-1 and DA Pamphlet 200-1.

In 1992 and 1994, both the Assistant Secretary of the Army for Research, Development, and Acquisition (SARDA) and the Deputy Assistant Secretary of the Army for the Environment, Safety, and Occupational Health within the Office of Assistant Secretary of the Army for Installations, Logistics, and Engineering (SAILE), authorized the Army Acquisition Pollution Prevention Support Office (AAPPSO), as the designated lead office for all Pollution Prevention (P^2) initiatives, and managing the Army ODC Elimination Program for the Department of the Army.

Subsequently, Executive Order 12843 signed in 1993 established a national policy and formal requirements for the Federal government to implement cost-effective programs to minimize the procurement of materials and substances that contribute to the depletion of the stratospheric ozone; and to give preference to the procurement of alternative chemicals, products, and manufacturing processes that reduce overall risks to human health and the environment by lessening the depletion of ozone in the upper atmosphere.

Finally, the Deputy Assistant Secretary of the Army (Environment, Safety and Occupational Health) issued policy memo 1994 entitled "Disposition of Excess Ozone-Depleting Substances at Army Installations." This policy expanded the DoD policy to turn in ODCs and included a definition of the term "excess."

ODC P² Army Goals

In response to the regulatory controls on ozone-depleting substances, the Army has established P² goals for the reduction and eventual elimination of ODCs in fire suppression equipment and systems, automotive vehicle degreasing and cleaning compounds, vehicle air conditioners, and facility air conditioning and refrigeration units which are sources of Class I and some Class II ODCs. The 1995 *"Strategic Guidance and Planning for Eliminating Ozone-Depleting chemicals from U.S. Army Applications,"* sets forth guidance and objectives for ODC elimination for facilities as summarized below:

- The Army would manage the ODC elimination policy and program centrally through the Army Acquisition Pollution Prevention Support Office (AAPPSO); and that execution of this strategy would be through the Major Command (MACOM) commanders and installations.

- The Army would rely on industry to the maximum extent possible for alternatives and technical solutions for ODC applications and phase-out.

- Each use of ODCs would a) be eliminated, or b) replaced with an environmentally safe alternative, approved by U.S. EPA's SNAP (Significant New Alternatives Policy), under the Clean Air Act, Title VI, Section 612.

- ODC retrofit or replacement of existing hardware would be required.

- Existing quantities of ODCs would be conserved and reused to the maximum extent possible and an ODC Reserve be setup for that specific purpose.

- All new chemicals introduced must receive a toxicity clearance from the Surgeon General before use.

Also according to Army Reserve guidelines established in line with Army Directives in the *"United States Army Reserve Command Pollution Prevention Plan, July 1997,"* Regional Support Commands (RSCs) should insure that facilities with significant ODC equipment and processes develop an ODC Elimination Plan. The following is the suggested content of the RSC ODC Plan:

- Actively practice ODC recycling where appropriate by purchasing ODC recycling equipment

- Establish preventative disposal procedures by removing refrigerants prior to scrapping
- Maximize refrigerant recycling by cascading refrigerants captured during equipment repair or scrapping

- For equipment that contains in excess of 50 pounds of refrigerant, maintain service records for refrigerants added to equipment and repair substantial leaks

- Assure personnel servicing equipment are Section 608 certified.

In most cases, ODC-containing equipment should be replaced through attrition. Factors to be considered in the life cycle analysis of equipment include cost of replacement or conversion, energy costs, and operation and maintenance costs. Mission-critical equipment such as weapon systems are to be retrofitted in stages by the DA and funded through alternative funding channels. Small appliances (containing less than 5 pounds ODC) are typically hermetically sealed, and therefore, difficult to retrofit with an alternative coolant. For this equipment, the Army and Army Reserve recommends that maintenance be performed by individuals certified under Section 608 of the Clean Air Act and that ODCs be reclaimed prior to scrapping the equipment. Chillers and air conditioners, on the other hand, typically are more easily retrofitted with an approved (SNAP) ODC substitute. As a rule-of-thumb, the Army and Army Reserve recommends that chillers older than fifteen years be replaced, and chillers less than five years be retrofitted. It is also recommended that refrigerant conversion be performed by the chiller manufacturer or by a contractor who represents the manufacturer.

ODC Elimination Plan

The Army Material Command has developed a generic ODC elimination plan for all Army facilities to use as guidance for developing their own specific facility plan. This plan provides a prioritization system for replacement or retrofits of equipment. Specific equipment types targeted for ODC elimination are Halon 1301 fire suppression systems and Halon 1211 fire extinguishers. When replacing a fire extinguishing system, the fire risk is first examined to determine if the fire suppression system is sufficient. Insufficient fire suppression systems and systems requiring frequent maintenance are given top priority for equipment retrofit and replacement. Low priority systems retrofit or replacement factors include recent installations, low maintenance, CFC-13 refrigerant (an alternative currently available), and sealed systems. All retrofit and replacement decisions are to be consistent with sound business practices, and make good economic sense. Those systems that have sufficient fire suppression are then prioritized based on the ease in which the system can be converted to a non-ODC system.

Guidance is also provided for eliminating CFC used in facility air conditioning and refrigeration applications. Once this equipment has been inventoried and prioritized for replacement or retrofit, primary emphasis is then placed on large air conditioning/refrigeration systems with capacities greater than 100 tons. Secondary emphasis is placed on smaller air conditioning and refrigeration units. The hierarchy for equipment replacement takes into account the 1) operating condition of the equipment, 2) alternative refrigerant chemicals available, 3) lubricant replacement, 4) additional parts required for retrofit, and 5) mechanical room safety modifications recommended by the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE). Each ODC application is reviewed individually to determine the easiest and most cost-effective method for eliminating ODC usage.

ODCs Army and Army Reserve Uses

The Army uses CFCs in systems for three engineering purposes: a) component cleaning, b) system cooling, and c) environmental control. System cooling and environmental control unit (ECU) applications include tactical refrigeration and chillers typically used in food service, photographic laboratories, medical, research and other laboratories, tactical shelter air conditioners, vehicle air conditioners; and, fire suppression equipment and systems.

The ODC refrigerants used to cool buildings, motor vehicles, food storage areas, ice machines, and water coolers may include R-12 (Dichlorodifluoromethane [CCl_2F_2]), R-22 (Monochlorodifluoro-methane [$CHClF_2$]), or R-502 (which is a combination of R-22 and R-115). The CFC Halon is widely used as a fire suppression agent, especially in facilities containing electronic equipment that would be damaged by water or other fire extinguishing agents. The typically used halon compounds include those in portable fire extinguishers (Halon 1211 [CF_2BrCl]), and those in fixed fire suppression systems and fire extinguishers (Halon 1301 [$CBrF_3$]).

P² Army Minimization Options for ODCs

The following are provided as minimization options for ODCs, They include:

- **Reduce** sources by Retiring Equipment based on need.
- **Retrofit** equipment with an EPA SNAP substitute based on need.
- **Replace** equipment with new EPA SNAP substitute based on need.

Both air conditioning and refrigeration operate on the principle of vapor compression to achieve cooling. This process has long relied on CFCs and HCFCs as the refrigerants of choice in the vapor compression process. The discovery of their probable effect on the ozone layer has resulted in the development of alternative processes, as well as development of new refrigerants.

The first substitute refrigerants developed for CFCs and HCFCs are known as hydrofluorocarbons (HFCs). Since they do not contain any chlorine atoms, HFCs are used, but have some drawbacks, such as higher equipment costs and lower efficiencies than CFC- or HCFC-based systems. In addition, HFCs contribute to global warming when vented. Some main factors to weigh when considering conversion to a substitute halon alternative are as follows:

- Is the candidate substitute been EPA SNAP approved?

- Has the candidate substitute been tested by a nationally recognized testing organization such as Underwriters Laboratories (UL) or Factory Mutual (FM)?

- Does the candidate substitute conform with the National Fire Protection Association Standard for Clean Agent Extinguishing System (NFPA Standard 2001)?

- Does the candidate substitute have zero ozone depletion potential and low global warming potential? If not, it may also be targeted for replacement sometime in the future, e.g., HCFCs.

- Are there non-halocarbon alternatives that would work for the application? If not, what are the halocarbon alternatives?

- Is the existing equipment compatible with the candidate substitute? If not, what are the performance compromises, costs, and retrofit requirements?

The EPA recommends the following strategy for developing effective waste minimization options for ODC reduction and phase-out by years:

- Procedural modification, e.g., modify normal Standard Operating Procedures (SOPs) for reduction and elimination
- Process modification, e.g., reduce, reuse, recycle as P^2 alternative
- Material substitution.

The general Army guidance for P^2 ODC elimination requires several sequential steps of implementation. These steps are outlined below:

- **Inventory of all CFC- and HCFC-based sources and chemicals available to replenish those systems**--i.e. 1) Location of the Equipment, 2) Ownership, 3) Equipment Type and Model, 4) Chemical Used (type, storage, allocation, amount), 5) Operating Record, 6) Maintenance Record, and 7) Future Plans.

- **Apply Conservation Measures** by establishing a strong maintenance plan aimed at conserving and recovering CFC chemicals.

- **The installation should reuse the refrigerant** from these systems as they are replaced or retrofitted to maintain the remaining air conditioners and refrigerators. The recovered refrigerants can be utilized throughout the elimination program as long as it is used in facility equipment on the installation.

- **Building a management plan to eliminate ODCs and establish priorities** such as personnel required to maintain equipment, repair, recover CFCs and retrofit equipment.

ODC Milestone Deadlines

The following table contains milestones and deadlines for ODC elimination.

Pollution Prevention ODC Milestone Deadlines				
Type of ODCs	**ODCs**	**PRODUCTION PHASE-OUT MILESTONES**		**RETROFIT & REPLACEMENT PHASE-OUT**
	100% Production Phaseout	**Milestone[1]**	**Milestone[2]**	**Milestone[3,4]**
Class I	Halon 1211, 1301, and 2402	1 January 1994	1 January 1994	
Class I	Chlorofluorocarbons (CFC) 11, 12, 13, 111, 112, 113, 114, 115, 211, 212, 213, 214, 215, 216, 217, 500, 502	1 January 1996	31 December 1995	*Before 1 January 2000
Class I	Carbon Tetrachloride	1 January 1996	31 December 1995	
Class I	1,1,1-Trichloroethane (Methyl Chloroform)	1 January 1996	31 December 1995	
Class I	Hydrobromofluorocarbons (HBFC)	1 January 1996	1 January 1996	
Class I	Methyl Bromide		1 January 2001	
Class II	HCFC-141b		1 January 2003	Before 1 January 2003
Class II	HCFC-142-b		1 January 2010	Before 1 January 2020
Class II	HCFC-22		1 January 2010	Before 1 January 2020
Class II	Other HCFCs	1 January 2030	1 January 2015	Before 1 January 2030

***Except refrigeration and air conditioning equipment - Before 1 January 2003.**

1 Copenhagen and London Amendments to the Montreal Protocol.
2 U.S. EPA Clean Air Act (42 U.S.C. 767a(a)), 40 CFR Part 82, Section 604.
3 Strategic Guidance and Planning for Eliminating Ozone-Depleting Chemicals from U.S. Army Applications.
4 "The Accelerated Phaseout of Ozone-Depleting Substances," Stratospheric Ozone Protection-Final Rule Summary, U.S. EPA, Washington, D.D., EPA 430-F-93-057, December 1993.

Conclusion

Building a management plan and establishing priorities for elimination of ODCs is a priority for each facility or installation. This plan needs to be part of the P^2 initiatives of the facility. With deadlines fast approaching (retrofit and replacement phase-out of Class I ODC before January 1, 2000), it is recommended that managers establish a plan and allocate the necessary funding now for ODC elimination.